THE DYNAMICS OF PENDULOUS VIBRATORS

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Abstract: This study presents the phases of the elaboration of the calculus model and the mathematical model for one direction pendulous vibrators utilized in equipment which generate technological vibrations for civil engineering, for building materials industry, for any other technical applications. Depending on calculus hypothesis, it was determined some simplified mathematical models which point out the analytical relations between structural and dynamical parameters of the vibrating system. This writing is useful in the research work and in designing of this type of vibrators and equipment, through the calculus formula for the amplitudes of the harmonically vibrations and for the necessary power and torque of the driving motor. The one direction pendulous vibrators power-actuated by various types of rotary engines have industrial applications where the driving is made through vertical vibrations. As applications it can mention diverse process industries (building materials, pharmaceuticals, metallurgy, machine building), agriculture, civil engineering. This study analyses a calculus model of this type of vibrators and proposes a complex and unitary mathematical model, which analytically evidences the influence of structural parameters on the dynamic characteristics of vibrator-organ to work system; by solving of this model, with diverse degrees of particularization, it offers explicit calculus relations used for designing work.

Under the hypothesis of small oscillations ($\sin\theta \approx \theta$, $\cos\theta \approx 1$, $\varphi >> \theta$), the mathematical model of steady state vibration ($\dot{\varphi} = \omega_0 = \frac{\pi n_0}{30} = ct.$, $\omega_0 t >> \theta$) of the pendulous vibrator is

$$\begin{cases} M_t\ddot{x} - (m_1 l_1 + m_2 l)\theta\ddot{\theta} - (m_1 l_1 + m_2 l)\dot{\theta}^2 - m_2 l_2 \omega_0^2 \cos(\omega_0 t) + b\dot{x} + kx = 0 \\ M_t\ddot{y} + (m_1 l_1 + m_2 l)\ddot{\theta} - (m_1 l_1 + m_2 l)\theta\dot{\theta}^2 - m_2 l_2 \omega_0^2 \sin(\omega_0 t) = 0 \\ \left(J_1 + m_2 l^2\right)\ddot{\theta} - (m_1 l_1 + m_2 l)\theta\ddot{x} + (m_1 l_1 + m_2 l)\ddot{y} - m_2 l l_2 \omega_0^2 \sin(\omega_0 t) + (m_1 l_1 + m_2 l) g\theta = -M_m \\ \left(-m_2 l_2 \ddot{x} + m_2 l l_2 \dot{\theta}^2 + m_2 g l_2\right)\sin(\omega_0 t) + \left(m_2 l_2 \ddot{y} + m_2 l l_2 \ddot{\theta}\right)\cos(\omega_0 t) = M_m \end{cases},$$

where x and y are the displacements of the vibrator, θ is the angular displacement of the pendulum and $\varphi = \omega_0 t$ is the rotation of the unbalanced mass.

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